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Task-Technology Fit and Individual Performance

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Abstract

A key concern in Information Systems (IS) research has been to better understand the linkage between information systems and individual performance. The research reported in this study has two primary objectives: (1) to propose a comprehensive theoretical model that incorporates valuable insights from two complementary streams of research, and (2) to empirically test the core of the model. At the heart of the new model is the assertion that for an information technology to have a positive impact on individual performance, the technology: (1) must be utilized and (2) must be a good fit with the tasks it supports. This new model is moderately supported by an analysis of data from over 600 individuals in two companies. This research highlights the importance of the fit between technologies and users' tasks in achieving individual performance impacts from information technology. It also suggests that task-technology fit, when decomposed into its more detailed components, could be the basis for a strong diagnostic tool to evaluate whether information systems and services in a given organization are meeting user needs.

Keywords: Task-technology fit, individual performance, impact of information technology

ISRL Categories: AA03, DC02, DC06, EI02, EL03, GB02

Introduction

The linkage between information technology and individual performance has been an ongoing concern in IS research. This article presents and tests a new, comprehensive model of this linkage by drawing on insights from two complementary streams of research (user attitudes as predictors of utilization and task-technology fit as a predictor of performance). The essence of this new model, called the Technology-to-Performance Chain (TPC), is the assertion that for an information technology to have a positive impact on individual performance, the technology *must be utilized*, and the technology *must be a good fit with the tasks it supports*.

This new model is consistent with one proposed by DeLone and McLean (1992) in that both utilization and user attitudes about the technology lead to individual performance impacts. It goes beyond the DeLone and McLean model in two important ways. First, it highlights the importance of task-technology fit (TTF) in explaining how technology leads to performance impacts. Task-technology fit is a critical construct that was missing or only implicit in many previous models. Second, it is more explicit concerning the links between the constructs, providing a stronger theoretical basis for thinking about a number of issues relating to the impact of IT on performance. These include: making choices for surrogate measures of MIS success,¹ understanding the impact of user involvement on performance, and developing better diagnostics for IS problems.

¹ "MIS Success" is variously described as improved productivity (Bailey and Pearson, 1983), changes in organizational effectiveness, utility in decision making (Ives, et al., 1983), higher relative value or net utility of a means of inquiry (Swanson, 1974; 1982), etc. Thus, MIS success ultimately corresponds to what DeLone and McLean (1992) label individual impact or organizational impact. For our purposes, the paper focuses on individual performance impacts as the dependent variable of interest.

This paper describes the technology-to-performance chain model, and its major relationships are tested empirically using data from over 600 individuals using 25 different information technologies and working in 26 different departments in two companies.

Models Linking Technology and Performance

Described below are the two research streams mentioned earlier and the limitations of relying completely on either one alone.

Utilization focus research

The first (and most common) of the two complementary research streams on which the TPC is based is the “utilization focus” stream. This stream employs user attitudes and beliefs to predict the utilization of information systems (e.g., Cheney, et al., 1986; Davis, 1989; Davis, et al., 1989; Doll and Torkzadeh, 1991; Lucas, 1975; 1981; Robey, 1979; Swanson, 1987; Thompson, et al., 1991). The top model in Figure 1 shows a rough model of the way in which technology is said to affect performance in this research.

Most of the utilization research is based on theories of attitudes and behavior (Bagozzi, 1982; Fishbein and Ajzen, 1975; Triandis, 1980). Aspects of the technology (for example, high quality systems (Lucas, 1975) or charge-back policies (Olson and Ives, 1982)) lead to user attitudes (beliefs, affect) about systems (for example, usefulness (Davis, 1989) or user information satisfaction (Baroudi, et al., 1986)). User attitudes, along with social norms (Hartwick and Barki, 1994; Moore and Benbasat, 1992) and other situational factors, lead to intentions to utilize systems and ultimately to increased utilization. Stated or unstated, the implication is that increased utilization will lead to positive performance impacts.

Task-technology fit focus research

A smaller number of researchers have focused on situations where utilization can often be as-

sumed and have argued that performance impacts will result from task-technology fit—that is, when a technology provides features and support that “fit” the requirements of a task. This view is shown by the middle model in Figure 1, in which fit determines performance (and sometimes utilization) but without the richer model of utilization from above as a critical predictor of performance.

The “fit” focus has been most evident in research on the impact of graphs versus tables on individual decision-making performance. Two studies report that over a series of laboratory experiments, the impact of data representation on performance seemed to depend on fit with the task (Benbasat, et al., 1986; Dickson, et al., 1986). Another study proposes that mismatches between data representations (a technology characteristic) and tasks would slow decision-making performance by requiring additional translations between data representations or decision processes (Vessey, 1991). Still others found strong support for this linkage between “cognitive fit” and performance in laboratory experiments (Jarvenpaa, 1989; Vessey, 1991).

The case has been made for a more general “fit” theory of tasks, systems, individual characteristics, and performance (Goodhue, 1988). This study proposes that information systems (systems, policies, IS staff, etc.) have a positive impact on performance only when there is correspondence between their functionality and the task requirements of users.

There have also been links suggested between fit and utilization (shown to the dotted arrow in the middle model of Figure 1). At the organizational level “fit” and utilization or adoption have been linked (Cooper and Zmud, 1990; Tornatzky and Klein, 1982). At the individual level, a “system/work fit” construct has been found to be a strong predictor of managerial electronic workstation use (Floyd, 1986; 1988).

Limitations of the utilization focus model

While each of these perspectives gives insight into the impact of information technology on performance, each alone has some important limitations. First, utilization is not always voluntary.

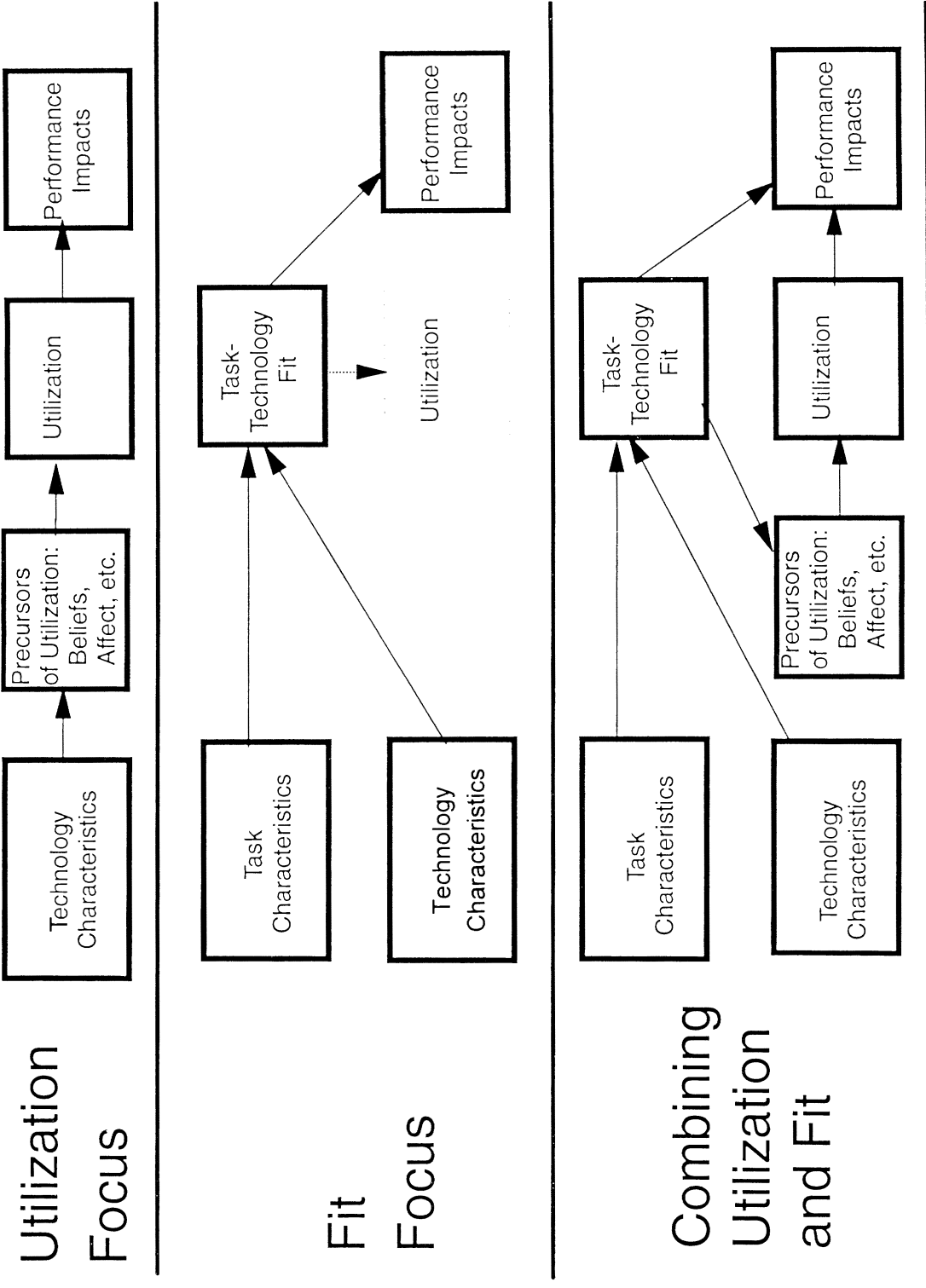


Figure 1. Three Models of the Link From Technology to Performance

For many system users, utilization is more a function of how jobs are designed than the quality or usefulness of systems, or the attitudes of users toward using them. To the extent that utilization is not voluntary, performance impacts will depend increasingly upon task-technology fit rather than utilization.

Second, there is little explicit recognition that more utilization of a system will not necessarily lead to higher performance. Utilization of a poor system (i.e., one with low TTF) will not improve performance, and poor systems may be utilized extensively due to social factors, habit, ignorance, availability, etc., even when utilization is voluntary. For example, a study involving IRS auditors found that even though they have positive attitudes toward Personal Computers (PCs) and use them extensively, utilization has little positive impact on performance, and possibly negative impacts (Pentland, 1989). The suggested reason for this was because PCs and their software were a poor fit to the task portfolio of the auditors (Pentland, 1989).

Limitations of fit focus models

Models focusing on fit alone do not give sufficient attention to the fact that systems must be utilized before they can deliver performance impacts. Since utilization is a complex outcome, based on many other factors besides fit (such as habit, social norms, and other situational factors), the fit model can benefit from the addition of this richer understanding of utilization and its impact on performance. The bottom model from Figure 1 shows the two perspectives combined, with performance determined jointly by utilization and TTF.

A New Model: The Technology-to-Performance Chain

Figure 2 shows a more detailed picture of the combination of theories focusing on utilization and task-system fit. This technology-to-performance chain (TPC) is a model of the way in which technologies lead to performance impacts at the

individual level.² By capturing the insights of both lines of research and recognizing that technologies must be utilized *and* fit the task they support to have a performance impact, this model gives a more accurate picture of the way in which technologies, user tasks, and utilization relate to changes in performance. The major features of the full model in Figure 2 are described below before the focus is narrowed to a reduced model that is more easily tested empirically.

Technologies are viewed as tools used by individuals in carrying out their tasks. In the context of information systems research, technology refers to computer systems (hardware, software, and data) and user support services (training, help lines, etc.) provided to assist users in their tasks. The model is intended to be general enough to focus on either the impacts of a specific system or the more general impacts of the entire set of systems, policies, and services provided by an IS department.

Tasks are broadly defined as the actions carried out by individuals in turning inputs into outputs.³ Task characteristics of interest include those that might move a user to rely more heavily on certain aspects of the information technology. For example, the need to answer many varied and unpredictable questions about company operations would move a user to depend more heavily upon an information system's capacity to process queries against a database of operational information.

Individuals may use technologies to assist them in the performance of their tasks. Characteristics of the individual (training, computer experience, motivation) could affect how easily and well he or she will utilize the technology.

Task-technology fit (TTF) is the degree to which a technology assists an individual in performing his or her portfolio of tasks. More spe-

² An earlier version of this model was first presented by Goodhue (1992).

³ There is potential for some confusion in terminology here. Organizational researchers sometimes define *technology* quite broadly as actions used to transform inputs into outputs (e.g., Perrow, 1967; Fry and Slocum, 1984). That is, technologies are the tasks of individuals producing outputs. This paper differentiates technologies from tasks.

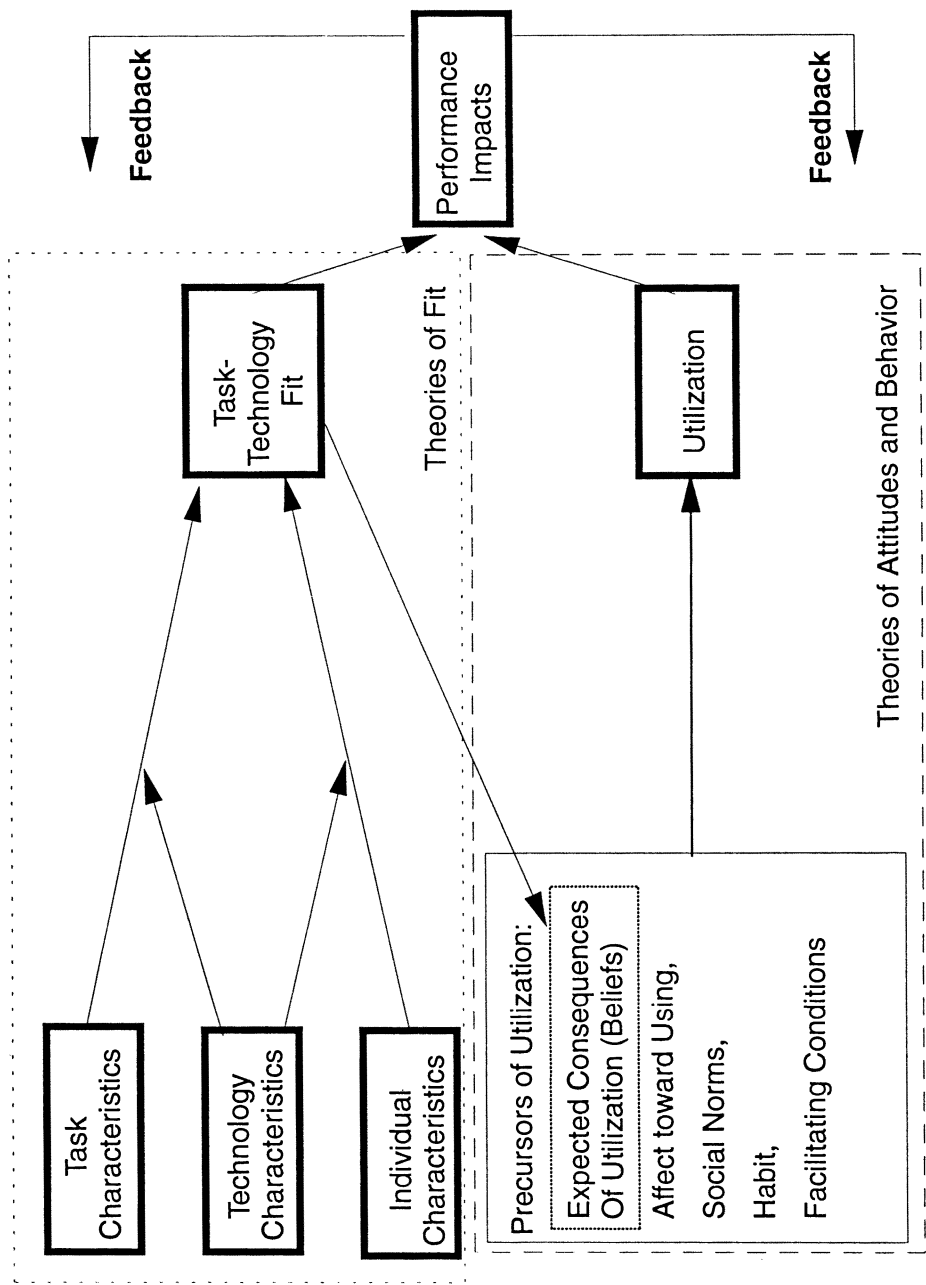


Figure 2. The Technology-to-Performance Chain

cifically, TTF is the correspondence between task requirements, individual abilities, and the functionality of the technology.⁴

The antecedents of TTF are the interactions between task, technology, and individual. Certain kinds of tasks (for example, interdependent tasks requiring information from many organizational units) require certain kinds of technological functionality (for example, integrated databases with all corporate data accessible to all). As the gap between the requirements of a task and the functionalities of a technology widens, TTF is reduced. Starting with the assumption that no system provides perfect data to meet complex task needs without any expenditure of effort (i.e., there is usually some non-zero gap), we believe that as tasks become more demanding or technologies offer less functionality, TTF will decrease (Goodhue, forthcoming).

Utilization is the behavior of employing the technology in completing tasks. Measures such as the frequency of use or the diversity of applications employed (Davis, et al., 1989; Thompson, et al., 1991; 1994) have been used. However, the construct is arguably not yet well understood, and efforts to refine the conceptualization should be grounded in an appropriate reference discipline (Trice and Treacy, 1988).

Since the lower portion of the TPC model in Figure 2 is derived from other theories about attitudes (beliefs or affect) and behavior (Bagozzi 1982; Fishbein and Ajzen, 1975; Triandis, 1980), it would seem an appropriate reference discipline. Consider the utilization of a *specific system* for a *single, defined task* in light of those theories. Beliefs about the consequences of use, affect toward use, social norms, etc. would lead to the individual's decision to use or not use the system. In this case, utilization should be conceptualized as the binary condition of use or no-use. We would not be interested in how long the individual used the system at this single, defined task, since length of use would be a conse-

quence of the size of the task and/or the TTF of the system, not the choice to use the system.

If the focus is expanded to include a portfolio of some number of tasks (such as in a field study of information systems use), then the appropriate conceptualization would be the *proportion* of times the individual decided to use the system (the sum of the decisions to use, divided by the number of tasks). Note that this is quite different from conceptualizing utilization as the length of time or the frequency with which a system was used. Knowing that an individual decided to use a system three times means one thing if there were only four tasks, but something else if there were 20 tasks.

The antecedents of utilization can be suggested by theories about attitudes and behavior, as described above. Note that both voluntary and mandatory utilization are reflected in the model. Mandatory use can be thought of as a situation where social norms to use a system are very strong and overpower other considerations such as beliefs about expected consequences and affect.

The impact of TTF on utilization is shown via a link between task-technology fit and beliefs about the consequences of using a system. This is because TTF should be one important determinant of whether systems are believed to be more useful, more important, or give more relative advantage. All of these related constructs have been shown to predict utilization of systems (Davis, 1989; Hartwick and Barki, 1994; Moore and Benbasat, 1992), though they are not the only determinant, as the model shows.

Performance impact in this context relates to the accomplishment of a portfolio of tasks by an individual. Higher performance implies some mix of improved efficiency, improved effectiveness, and/or higher quality. As shown in Figure 2, not only does high TTF increase the likelihood of utilization, but it also increases the performance impact of the system regardless of why it is utilized. At any given level of utilization, a system with higher TTF will lead to better performance since it more closely meets the task needs of the individual.

Feedback is an important aspect of the model. Once a technology has been utilized and performance effects have been experienced, there

⁴ Perhaps a more accurate label for the construct would be task-individual-technology fit, but the simpler TTF label is easier to use.

will inevitably be a number of kinds of feedback. First, the actual experience of utilizing the technology may lead users to conclude that the technology has a better (or worse) impact on performance than anticipated, changing their expected consequences of utilization and therefore affecting future utilization. The individual may also learn from experience better ways of utilizing the technology, improving individual-technology fit, and hence the overall TTF.

A reduced model for testing

The TPC is a large model and difficult to test in a single study. Arguably, portions of it have already been tested by a variety of researchers. Support for a “fit” relationship between task characteristics, technology characteristics, and individual characteristics on the one hand, and user evaluations of TTF on the other (i.e., the top portion of Figure 2) was found by Goodhue (forthcoming). Support for the link between TTF and performance (i.e., the top portion of Figure 2 plus performance impacts) was found by Jarvenpaa (1989) and Vessey (1991). Support for the precursors of utilization (i.e., the bottom box) has been found by Adams, et al. (1992), Davis (1989), Davis, et al. (1989), Mathieson (1991), and Thompson, et al. (1991; 1994). None of this work has been tested across the full scope of the model.

The goal of our study was to test across all the core components of the model, from task and technology to performance impacts, with a particular emphasis on the role of task-technology fit. Figure 3 shows the reduced model to be tested. The biggest change from Figure 2 to Figure 3 is the direct link from TTF to utilization in Figure 3. This is based on two important assumptions: first, that TTF will strongly influence user beliefs about consequences of utilization; and second that these user beliefs will have an effect on utilization. Specifically, we tested the following propositions (see Figure 3):

Proposition 1: User evaluations of task-technology fit will be affected by both task characteristics and characteristics of the technology.

Proposition 2: User evaluations of task-technology fit will influence the utilization of information systems by individuals.

Proposition 3: User evaluations of task-technology fit will have additional explanatory power in predicting perceived performance impacts beyond that from utilization alone.

Methodology

Research design

As is common in this type of research, we faced a decision of whether to test the TPC model within a narrowly controlled domain and generalize to a more global domain, or to test the model in a more generalized domain. A more narrowly controlled domain would have removed extraneous influences, but made generalization more difficult. We decided to focus at a more macro level and to span multiple technologies, multiple tasks, multiple types of users, and multiple organizational settings. Thus, we were testing to see whether a general measure of TTF (at the individual level) would exhibit the relations suggested by the TPC model. If it did, then we would have demonstrated support for the TPC model at a very high level of generalization.

The sample included over 600 users, employing 25 different technologies, working in 26 different non-IS departments in two very different organizations. The sample spanned the organizational hierarchy from administrative/clerical staff to vice president and up. In company A (a transportation enterprise) questionnaires were sent out to approximately 1200 users (a random sample of a major fraction of the company's non-union, non-IS employees, stratified by department). A total of 400 questionnaires were completed and returned to a company representative, for a response rate of approximately 33 percent.

For company B (an insurance company), the questionnaire was delivered to a majority of non-IS employees. Employees were given 30 minutes of company time to complete the survey. A total of 262 were returned, for a gross

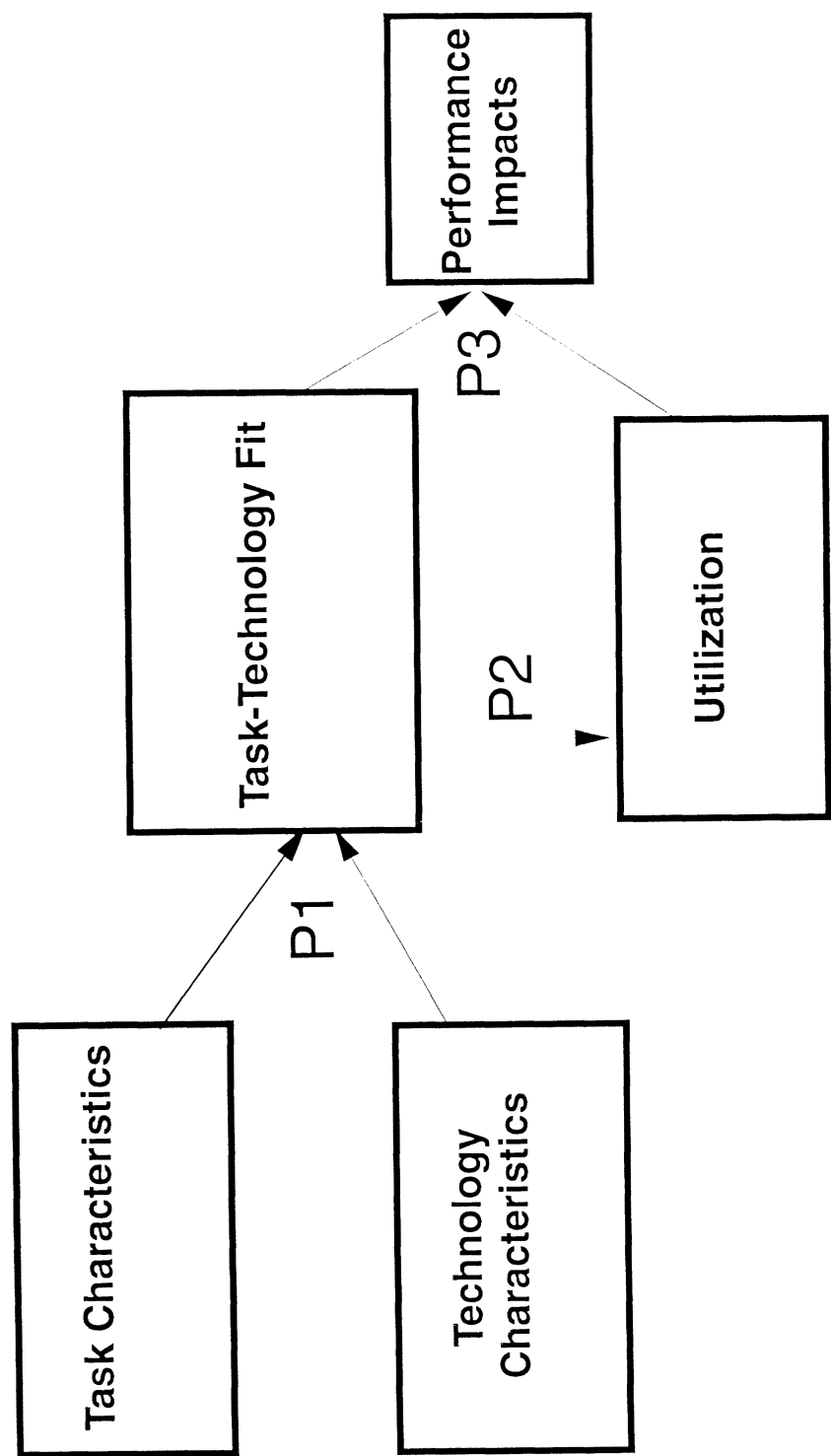


Figure 3. The Subset of the Technology-to-Performance Chain to Be Tested

response rate of 93 percent. The total usable respondents from both companies was 662.⁵

Measures, measurement validity, reliability

Where possible, measures were adapted from previous research. Because of a lack of adequate measurement scales, however, it was necessary to develop and refine some measures specifically for this study.

Task-technology fit has been measured by Goodhue (1993; forthcoming) within the user task domain of IT-supported decision making. From Goodhue's instrument we borrowed multiple questions on each of 14 dimensions of TTF addressing the extent to which existing information systems support the identification, access, and interpretation of data for decision making.

To expand the task domain somewhat, two additional IT-supported user tasks were added: (1) responding to changed business requirements with new and modified systems, and (2) executing day-to-day business transactions. For these two new tasks multiple questions were developed on each of seven new dimensions addressing the extent to which IS meets user task needs: having sufficient understanding of the business, having sufficient interest and dedication, providing effective technical and business planning assistance, delivering agreed-upon solutions on time, responsiveness on requests for services, production timeliness, and impact of IS policies and standards on ability to do the job. Altogether this resulted in 48 questions measuring 21 dimensions of TTF.

Based on an assessment of the reliability and discriminant validity of the questions, 14 questions (and 5 dimensions) were dropped as being unsuccessfully measured.⁶ Using a principal components factor analysis with promax rotation, the remaining 34 questions (including 16 of the 21 original dimensions) were collapsed into eight clearly distinct factors of TTF. For all questions, factor loadings were at least .50 on the primary factor, and no more than .45 on any secondary factor. For only one question was the difference between the primary and the secondary loading less than .20, and in this one case the difference was .10.

Table 1 shows the mapping from the 16 remaining dimensions of TTF to the eight final TTF factors, as well as the Cronbach's alpha reliabilities for the eight factors, ranging from .60 to .88. This grouping of dimensions seemed quite reasonable, since similar dimensions were collected into more aggregate but still coherent TTF factors. The final eight components of TTF that were successfully measured included (1) data quality; (2) locatability of data; (3) authorization to access data; (4) data compatibility (between systems); (5) training and ease of use; (6) production timeliness (IS meeting scheduled operations); (7) systems reliability; and (8) IS relationship with users. The first five factors focused on meeting task needs for using data in decision making. The next two focused on meeting day-to-day operational needs, and the last focused on responding to changed business needs. The successful TTF questions are listed in the Appendix, Part A.

Task characteristics and their impact on information use have been studied by a great many researchers (e.g., Culnan, 1983; Daft and Macintosh, 1981; O'Reilly 1982). Following Fry and Slocum's (1984) suggestion of a general characterization of tasks, Goodhue (forthcoming) combined Perrow's (1967) and Thompson's (1967) dimensions and successfully measured a two-dimensional construct of task characteristics: non-routineness (lack of analyzable search behavior) and interdependence (with other organizational units).

⁵ A concern with the two-company sample described above is that the model may apply so differently in the two companies that it is inappropriate to pool the data for a single analysis. We used Neter and Wasserman's (1974, p. 160-161; see also Pedhazur, 1982, pp. 436-450) test for the equivalence of two regression lines to test whether it is appropriate to pool the data from the two companies. This involves testing a full model giving each company its own intercept and beta values, and comparing that to a restricted model with a single intercept and a single set of shared beta values. This test was performed for the regressions predicting utilization and performance impacts. In neither case was the improvement in fit for the full model significant at the .05 level, supporting our approach of pooling the data.

⁶ Details of the analysis of the measurement validity of all measures, as well as a correlation matrix, are available from the authors upon request.

**Table 1. Results of Factor Analysis:
16 Original Task-Technology Fit Dimensions*
And 8 Final Task-Technology Fit Factors**

8 Final TTF Factors	16 Original TTF Dimensions (After poor questions dropped)	Cronbach's Alpha
Quality	Currency of the data Right data is maintained Right level of detail	.84
Locatability	Locatability Meaning of data is easy to find out	.75
Authorization	Authorization for access to data	.60
Compatibility	Data compatibility	.70
Ease of Use/Training	Ease of Use Training	.74
Production Timeliness	Production Timeliness	.69
Systems Reliability	Systems Reliability	.71
Relationship With Users	IS understanding of business IS interest and dedication Responsiveness Delivering agreed-upon solutions Technical and business planning assistance	.88

* After 5 of the original 21 TTF dimensions were dropped as unsuccessfully measured.

Five measures of task characteristics (three questions on non-routineness and two on interdependence) were adopted from Goodhue's (forthcoming) study, as shown in the Appendix, Part B. A factor analysis separated the questions into two factors with all questions loading at least .51 on their primary factor, and no more than .36 on their secondary factor. Cronbach's alpha reliabilities were .73 and .76 for non-routineness and interdependence respectively.

In addition to these general characteristics of tasks, several researchers have suggested managerial level as a determinant of user evaluations of IS (e.g., Cronan and Douglas, 1990; Franz and Robey, 1986). It is certainly true that the kinds of tasks users engage in (and the demands they make on their information systems and service providers) should vary considerably from clerical staff to low-level managers to higher-level managers. As a pragmatic proxy to capture these kinds of task differences, dummy variables were used for each of eight groupings of job title. Job titles in the two companies are shown in Table 2, matched where possible across the two companies. Though no specific hypotheses were made, we expected that differences in job title would affect user evaluations of TTF.

Technology characteristics facing users could be measured along a number of dimensions. With this measure we focused on two proxies for the underlying characteristics of the technology of information systems: first, the information systems used by each respondent, and second, the department of the respondent. The two organizations provided a large range of information systems for their employees. As part of the customization of the questionnaire, about 20 major systems in each company were identified. Each respondent identified up to five of these that they actually used. Twenty-five major systems (13 in Company A and 12 in Company B) were used by a minimum of five employees.

Rather than try to define each system in terms of its characteristics, we made the simplifying assumption that the characteristics of any given system are the same for all who use that system. For respondents who used only a single system, the characteristics were captured by a dummy variable (1 indicates use of this system; 0 indicates no use). Where respondents used more than one system, the dummy variables were weighted. The weighting was accomplished by simply dividing 1 by the number of major systems used. For example, a respondent who used three major systems would receive a

weighting of .33 for each of these three and a weighting of zero for all other systems. This approach allowed us to capture inherent differences between technologies without having to explicitly define those differences. In effect, the collection of dummy variables for system was used as a proxy for different, unspecified system characteristics.

The department of the respondent was also used as a second proxy measure for the characteristics of information systems. IS departments may have differentiated between user departments in terms of attention, emphasis, priority, and relationship management, perhaps because of the organization's strategic direction or historic inertia. These differences could have affected the level of service experienced by respondents in the different departments. A set of departmental dummy variables was used to capture the potentially different levels of attention paid by IS departments to each of 26 distinct user departments.

These were somewhat crude measures of characteristics of information systems and services, involving a great many dummy variables. Given our relatively large sample size, however, these measures did allow us to test the assertion that user evaluations were a function of the underlying systems used and the departments users were in.

Utilization should ideally be measured as the proportion of times users choose to utilize systems. Unfortunately, this proportion was extremely difficult to ascertain in a field study. In addition, there was also the problem of mandatory use. In many field situations, use of a system may be mandated as part of a job description. For example, a claims processor with the insurance company (Company B) had

no choice but to use the system provided by his or her IS department. Regardless of the claims processor's evaluation of the system, it was not possible to process claims without using it.

Our solution was to conceptualize utilization as the extent to which the information systems have been integrated into each individual's work routine, whether by individual choice or by organizational mandate. This reflected the individual (or organizational) choice to accept the systems, or the institutionalization of those systems.

We operationalized this by asking users to rate how dependent they were on a list of systems available in their organizations. Respondents selected up to five systems that were major sources of information for them personally and self-reported on system-specific dependence. Dependence on each system was rated on a three-point scale (0— not very dependent; 1— somewhat dependent; 2—very dependent). Overall dependence on systems (our measure of utilization) was calculated as the total dependence reported on up to five systems (the sum of the dependence responses).

Performance impact was measured by perceived performance impacts since objective measures of performance were unavailable in this field context, and at any rate would not have been compatible across individuals with different task portfolios. Three questions were used that asked individuals to self-report on the perceived impact of computer systems and services on their effectiveness, productivity, and performance in their job. Low correlations between one question and the others (.23 and .21) suggested that it was measuring something quite different from the other two (in this case, problems with the IS department as opposed to impact of systems on performance). This third question was

Table 2. Matched Job Titles Across the Two Companies

	Transportation Company	Insurance Company
Group 1	Administrative staff	Clerical staff
Group 2	Analyst	Technical
Group 3	Supervisor/asst. manager	Supervisor
Group 4	Manager/asst. director	Manager
Group 5	Director/asst. superintendent	Director
Group 6	Superintendent/general super.	VP and up
Group 7		Professional level
Group 8	Trainmaster, Roadmaster	

Table 3. Tests of the Influence of Task and System on TTF:
Results of Regression Analyses

TTF Factor	Non-Routine ¹	Inter-Dependence ¹	Job ²	Systems ²	Department ²	Adj. R-Square ³
Relationship	-.11	.01	0.67	1.27	.87	.04*
Quality	-.27***	-.04	0.92	1.24	1.02	.12***
Timeliness	-.12	-.04	1.02	1.26	1.72*	.13***
Compatability	-.37***	-.11*	4.92***	1.07	1.47	.25***
Locatability	-.26***	.04	1.86	1.52*	1.43	.13***
Ease/Training	-.15**	-.03	0.94	1.19	1.78**	.10***
Reliability	.00	-.13**	1.95	1.53*	1.33	.10***
Authority	-.29***	-.03	3.48***	0.87	1.10	.09***

¹ Beta Coefficients from regression analysis.

² F-statistic, computed by removing the group of dummy variables and comparing the results from the reduced model to those from the full model.

³ Significance of the regression is indicated by the asterisks on the Adjusted R-Square.

Significance Key: * = Significant at .05; ** = Significant at .01; *** = Significant at .001.

removed. The Cronbach's alpha for the two remaining questions was .61, certainly lower than desired, but marginally acceptable. The wording of the two remaining questions is shown in the Appendix, Part C.

Empirical Test of the Model

Specific propositions and analysis approach

Descriptive statistics are shown in the Appendix, Part E. Figure 4 shows the model from Figure 3, with the specific measures for each construct added. Our choice of analysis techniques was based primarily on the perceived stage of theory development. Although structural equation modeling (as embodied in the LISREL program) would enable testing the entire model simultaneously, it requires very strong, precise theory (Barclay, et al., forthcoming) with well-established measures. This research was still early in the theory generation phase, and therefore we decided to use what Fornell (1982; 1984) refers to as first generation analysis techniques—in this case multiple regression.

P1: Do Task and Technology Characteristics Predict TTF?

The arrows leading into the Task-Technology Fit box in Figure 3 show Proposition 1. Strong sup-

port would require that each of the eight regressions of TTF be significant and that in each regression at least some measure of task (non-routineness, interdependence, or the group of dummy variables for job title) and some measure of technology (groups of dummy variables for systems used or department) be a significant predictor. Table 3 shows the analysis results.

Testing the significance of job title, system, and department was somewhat involved, since each of these was operationalized as a *group of dummy variables*. We followed the approach suggested by Neter and Wasserman (1974, p. 274) and used a general linear test for the significance of each group of dummy variables in turn. Therefore, each line in Table 3 actually represents four separate regressions: a full regression with all dummy variables included and three additional regressions, dropping in turn the job dummy variables, the systems dummy variables, and the department dummy variables. Columns 3, 4, and 5 show the F-tests for the significance of groups of dummy variables (job title, systems, and department) obtained by comparing the full model to each of three restricted models. Columns 1 and 2 show the impact of non-routine tasks and interdependent tasks, directly obtainable from the full regression since these are not groups of dummy variables.

The R^2 values for the full regressions with all dummy variables ranged from .14 to .33, with adjusted R^2 values from .04 to .25. All but one

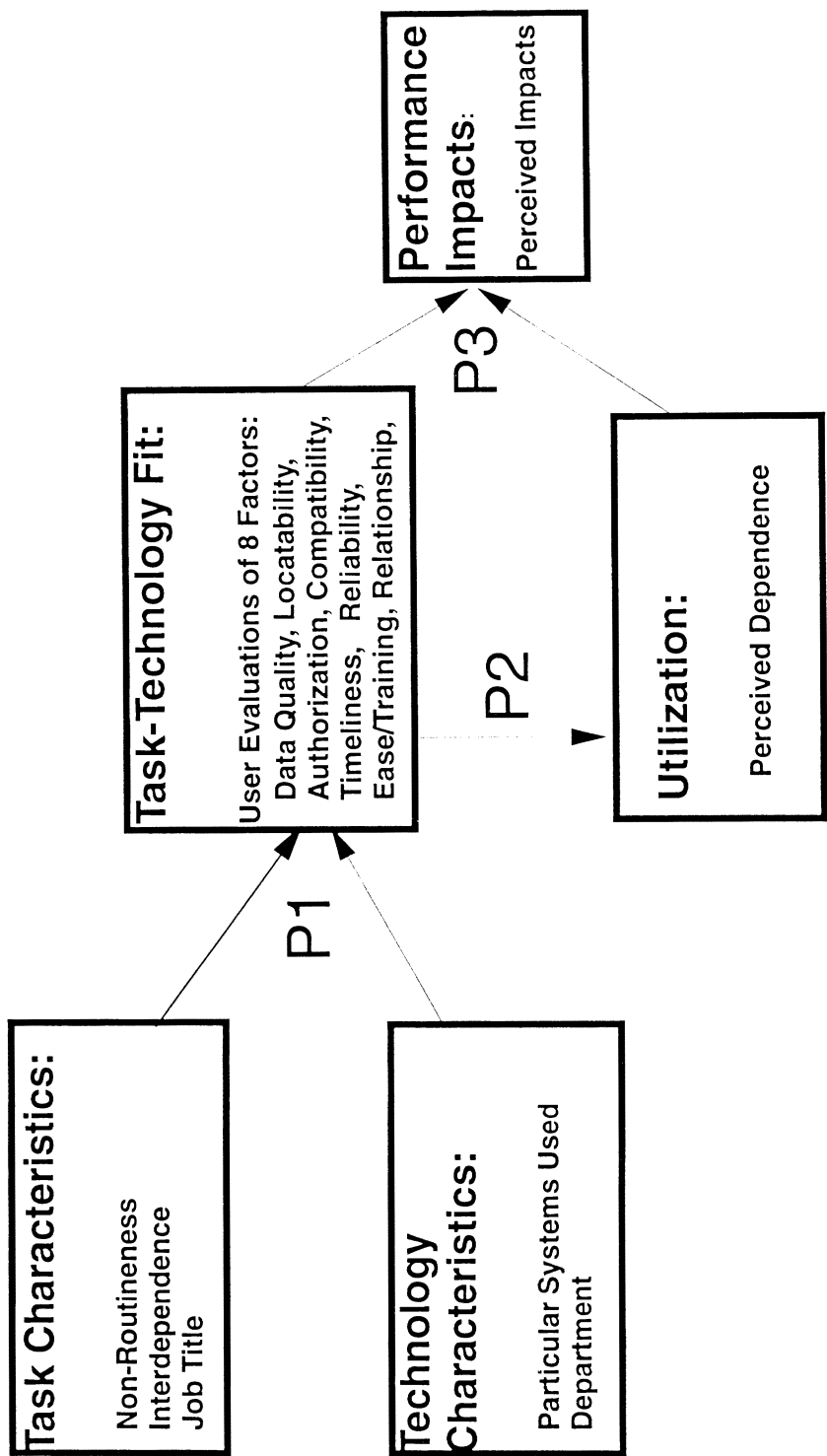


Figure 4. Measurements and Analyses to Be Conducted
(Measures are shown in small type below each construct.
Regressions were run for each of 8 Factors of TTF, for
Perceived Dependence; and for Perceived Impacts.)

of the regressions (the one predicting the quality of the relationship with IS) was significant at greater than the .001 level. At least one task characteristic was significant in six out of eight regressions, and at least one technology characteristic was significant in four out of eight. This is moderate support for Proposition 1. Below is a more detailed examination of the findings.

Effect of Task Characteristics on TTF. The strongest effect of task characteristics on TTF was from non-routine tasks. We found that individuals engaged in more non-routine tasks rated their information systems lower on data quality, data compatibility, data locatability, training/ease of use, and difficulty of getting authorization to access data (note the significance and the negative coefficients in column 1 of Table 3). This is consistent with the idea that because of the non-routine nature of their jobs, these people are constantly forced to use information systems to address new problems, such as seeking out new data and combining it in unfamiliar ways. Thus, they make more demands on systems and are more acutely aware of shortcomings. Interdependence of job tasks (column 2 of Table 3) was observed to influence perceptions of the compatibility and reliability of systems.

Finally, two factors of TTF are clearly affected by job level (column 3 of Table 3): compatibility and ease of getting authorization for access. Tables 4 and 5 show a more detailed analysis of the specific impact of the various job titles on these two factors. Lower and middle-level staff and managers found the data least compatible, while upper-level management found it most compatible. This is consistent with the proposition that upper-level management is often shielded from the hands-on difficulties of bringing together data from multiple sources and sees it only after the difficulties have been ironed out. It is lower and mid-level individuals who must pay with effort and frustration for data incompatibilities.

Similarly, Table 5 shows that upper-level management found it much easier obtaining authorization for access to data. On the other hand, administrative and clerical staff, with less organizational clout, faced red tape in getting permission to access the data they need.

Effect of Technology Characteristics on TTF.

The two proxies for characteristics of the technology were "systems used" and "department." Together these were significant predictors for four of the eight factors of TTF. The specific findings (see columns 4 and 5 of Table 3) have good face validity, although not all anticipated influences were observed.

For example, department is a significant predictor of user evaluations of production timeliness and of training/ease of use. If IS groups focus special emphasis on strategically important or powerful departments, we might expect that different levels of training and easier-to-use, more up-to-date systems would be provided to those departments. To the extent that IS groups have consistent standards for production turnaround, interface design, training policies, and so on, there are likely some departments for whom these standards are more appropriate than for others. A third area where we expected to see differences between departments, but did not, was the relationship with IS. (But see footnote 7 below.)

Systems used is a significant predictor of locatability and systems reliability. This too conforms to our expectations. We might expect that some systems are better than others for locatability of data or for system reliability, and users reflect that in their ratings. Another area where we expected to see differences between systems, but did not, was in the quality of the data. It is possible that our proxy measures of technology characteristics were too crude to pick up any but the strongest influences within this study.⁷

⁷ The absence of an effect of department on relationship with IS and of system on quality of the data is sufficiently perplexing to suggest doing some secondary exploratory analysis. Since some systems may be department specific, there is the possibility that including dummy variables for both department and system in the same regression (47 dummy variables in all) dilutes the impact that either group alone would have. For this reason the data were reanalyzed, dropping system from the analysis of relationship with IS and dropping department from the analysis of quality. Under these circumstances we found both of the expected relationships. Without system in the analysis, department is a significant (.05) predictor of relationship with IS. Without department in the analysis, system is a significant (.05) predictor of quality. This suggests that with stronger measures of technology characteristics, this aspect of the model might have stronger empirical support.

Table 4. Effect of Job Titles on User Evaluations of Data Compatibility*

Administrative/Clerical Staff	-.33
Manager/Assistant Director	-.27
Director/Assistant Superintendent	-.23
Supervisor/Assistant Manager	-.10
Analyst/Technical	-.08
Trainmaster/Roadmaster	.00
Professional	.26
Superintendent/VP and up	.29

* Job titles are ordered by impact from more negative to more positive. The numbers shown are the regression beta coefficients for the dummy variables reflecting membership in each job category. (Overall effect is significant at .001.)

In hindsight, it seems reasonable that characteristics of the technology would influence some but not all TTF components. For example, it is unlikely that differences between systems will have any influence on whether a user has the authority to access data; it is much more likely that job level will influence authority. Overall, these results suggest that task and technology characteristics do influence user ratings of task-technology fit, giving moderate support for proposition P1.

P2: Does TTF Predict Utilization?

The arrow from Task-Technology FIT to Utilization in Figure 3 shows Proposition 2. Strong support would require a significant regression and significant *positive* links between at least some of the eight TTF factors and utilization. The results (shown in Table 6) provide little support for the hypothesized relation. Although the regression as a whole and three of the path coefficients were statistically significant, the adjusted R^2 was only .02.

In addition, two of the three significant path coefficients (reliability of systems and relationship with IS) had negative path coefficients. Interpreted within a theoretical framework in which attitudes (beliefs, affect) determine behavior, the two negative links suggest that users who believe that systems are less reliable and who are less positive about the relationship with IS, will

be more likely to use the systems. This contrary behavior seems implausible.

A more compelling interpretation is that in this case the causal effect works in the other direction (through the feedback mechanism shown in Figure 2). For example, perhaps individuals who use the systems a great deal and are very dependent on them will be more frustrated by system downtime and the performance impacts it engenders. These highly dependent users are more likely to be stymied in their work by downed systems and more likely to rate those systems as unreliable. Similarly, people who are more dependent on systems might be more frustrated with poor relationships with the IS department and might give poorer evaluations of that relationship. This is quite different from numerous findings showing the link from user attitudes (beliefs, affect) to utilization (e.g., Davis, 1989; Hartwick and Barki, 1994; Moore and Benbasat, 1992; Thompson, et al., 1991), but is consistent with arguments made by Melone (1990) that under certain circumstances utilization will influence attitudes.

Several possible explanations for lack of support for Proposition 2 should be noted. First, this paper has conceptualized utilization as dependence on information systems, rather than on the more common concept of duration or frequency of use. Though we have raised some questions about the applicability of these other conceptualizations in a field study with portfolios of tasks,

Table 5. Effect of Job Titles on User Evaluations of Ease of Authorization*

Administrative/Clerical Staff	-.32
Analyst/Technical	-.11
Manager/Assistant Director	.00
Trainmaster/Roadmaster	.00
Supervisor/Assistant Manager	.06
Director/Assistant Superintendent	.06
Superintendent/VP and up	.21
Professional	.31

* Job titles are ordered by impact from more negative to more positive. The numbers shown are the regression beta coefficients for the dummy variables reflecting membership in each job category. (Overall effect is significant at .001.)

it might be that this shift in conceptualization is responsible for the weak link between TTF beliefs and behavior. Testing this was possible in a secondary analysis since for Company B we had gathered additional utilization measures for duration and frequency of use. Two additional regressions were run, one with TTF predicting duration and the other with TTF predicting frequency. Though the R^2 increased to .10 for both new regressions, in each case the strongest link by far was between negative beliefs about “systems reliability” or “relationship with IS” and greater utilization. Thus, it appeared that our conceptualization of utilization is not responsible for the lack of support for Proposition 2.

A more promising explanation is that the direct link between TTF and utilization proposed for Figure 3 may not be justified in general. That is, TTF may not dominate the decision to utilize technology. Rather, other influences from attitudes and behavior theory such as habit (Ronis et al., 1989), social norms (and mandated use), etc. may dominate, at least in these organizations. This would suggest that testing the link between TTF and utilization requires much more detailed attention to other variables from attitudes and behavior research.

A third possibility is that none of the current conceptualizations of utilization are well suited for field settings where many technologies are available and individuals face a portfolio of tasks. The resolution to this dilemma will have to await further research.

P3: Does TTF Predict Performance Impact Better Than Utilization Alone?

Finally, the arrows from Task-Technology Fit and Utilization to Performance Impacts show Proposition 3. Strong support would require that both TTF and Utilization be significant predictors of Performance Impacts. Again the test suggested by Neter and Wasserman (1974, p. 274) was used to explicitly test for the importance of adding the eight TTF factors as a group to a regression predicting performance using utilization.

To get a complete picture, we ran three regressions predicting performance impact, using three different sets of independent variables: (1) only utilization, (2) only the eight TTF factors, and (3) both the eight TTF factors and utiliza-

tion. The results are shown in Table 7. Utilization alone explained 4 percent (adjusted R^2) of the variance in performance, while TTF alone explained 14 percent. Together, TTF and utilization explained 16 percent of the variance.⁸ The F-test of the improvement in fit from adding the eight TTF factors as a group was significant at the .001 level.

Table 7 (the full Model 3) shows that quality of the data, production timeliness, and relationship with IS all predict higher perceived impact of information systems, beyond what could be predicted by utilization alone.⁹ Though we need to be careful about generalizing too freely about the impact of specific factors of TTF from a sample including only two companies (including more companies in our sample might bring other factors into sharper focus), the results do strongly support Proposition 3. It appears that performance impacts are a function of both task-technology fit and utilization, not utilization alone.

Conclusion

Even with some caveats, the TPC model represents an important evolution in our thinking from the earlier models in Figure 1, which shows how technologies add value to individual performance. We found moderately supportive evidence that user evaluations of TTF are a function of both systems characteristics and task characteristics, and strong evidence that to predict performance both TTF and utilization must be included. Evidence of the causal link between TTF and utilization was more ambiguous, with the suggestion that, at least in these companies, utilization could cause beliefs about TTF through feedback from performance outcomes.

⁸ Although an adjusted R^2 of .16 is not high, it is in line with results from other field research predicting user perceptions of performance impacts (for example, Franz and Robey, 1986).

⁹ One perplexing finding from Model 2 in Table 7 is the significant negative relationship between compatibility and performance impacts. However, this relationship drops to insignificance with Model 3 (including utilization), which we believe to be the correctly specified model. This suggests that the negative Model 2 relationship is spurious.

Table 6. Test of the Influence of TTF on Utilization (Dependence): Regression Results

TTF Factor	Beta Coefficient	t-value	Significance	Adjusted R-Square ¹
Relationship	-.21*	-2.11	.04	.02*
Quality	.08	0.76	.45	
Timeliness	.15*	2.08	.04	
Compatability	-.13	-1.57	.12	
Locatability	.14	1.04	.16	
Ease/Training	.16	1.26	.21	
Reliability	-.24*	-2.44	.02	
Authority	.06	0.73	.47	

¹ Significance of the regression is indicated by the asterisks on the Adjusted R-Square.

Significance Key: * Significant at .05; ** Significant at .01; *** Significant at .001.

However, the cumulative evidence of previous research showing the impact of usefulness (Adams, et al., 1992; Davis, et al., 1989; Mathieson, 1991), relative advantage (Moore and Benbasat, 1992), and importance (Hartwick and Barki, 1994) on utilization suggests that at least under some circumstances a link between TTF and utilization exists.

This new TPC model provides a fundamental conceptual framework useful in thinking about a

number of issues in IS research. Several examples are discussed below.

Implication for surrogates of IS success

Since performance impacts from IT are difficult to measure directly, we often resort to surrogate measures of IS success. If appropriate surrogates are to be chosen, accurate models of the way information systems and services deliver

Table 7. Test of the Influence of TTF and Utilization on Performance Impact: Regression Results

TTF Factor	Beta Coefficient	t-value	Significance	Adjusted R-Square ¹
Model 1: Utilization Only				
Utilization	.13***	5.08	.0001	.04***
Model 2: TTF Only				
Relationship	.11*	2.06	.04	.14***
Quality	.24***	3.92	.0001	
Timeliness	.12**	2.89	.004	
Compatability	-.12**	-2.52	.01	
Locatability	.07	1.25	.21	
Ease/Training	.12	1.76	.08	
Reliability	-.09	-1.67	.10	
Authority	-.01	-0.07	.95	
Model 3: Utilization and TTF				
Relationship	.12*	2.08	.04	.16***
Quality	.21***	3.32	.001	
Timeliness	.11**	2.65	.009	
Compatability	-.08	-1.71	.09	
Locatability	.09	1.64	.10	
Ease/Training	.04	0.54	.59	
Reliability	-.06	-1.06	.29	
Authority	-.01	-0.07	.94	
Utilization	.11***	4.32	.0001	

¹ Significance of the regression is indicated by the asterisks on the Adjusted R-Square.

Significance Key: *Significant at .05; **Significant at .01; ***Significant at .001.

value are needed. The TPC model is useful in re-evaluating possible choices.

Many researchers have suggested that utilization is an appropriate surrogate when use is voluntary, and user evaluations are appropriate when use is mandatory (e.g., Lucas, 1975; 1981). If, as the model suggests, performance impacts are a joint function of utilization and TTF, then neither alone is a good surrogate except under very limited circumstances.

One might argue that either construct would be a good surrogate if the other were assured. For example, TTF might be a good surrogate if utilization were assured (i.e., mandatory). However, evidence from a recent study (Moore and Benbasat, 1992) suggests that voluntariness exists on a continuum, with most individuals engaging in partly voluntary behavior. If utilization is partly voluntary, then TTF alone is an incomplete surrogate for IS success. Similarly, though utilization might be a good surrogate if TTF were assured, it is rare that we could be sure a priori that information systems fit user needs and abilities exactly.

We might also defend using only one of the constructs as a surrogate for success if we could assume that utilization and TTF were highly correlated. Certainly in the two companies studied in this research, the link between TTF and utilization was not strong. If most utilization is partly voluntary, and utilization is only partly driven by expectations of performance impacts, then an appropriate surrogate for performance impacts should include measures of both TTF and utilization.

Implications for the impact of user involvement

By far the majority of research on user involvement and IS success has looked at the impact of user involvement on user attitudes, and ultimately on user commitment to utilize the system. Though this effect is not unimportant, the TPC model also directs our attention to another aspect of successful system implementation. When users understanding the business task are involved in systems design, it is more likely that the resulting system will fit the task need. Thus, user involvement potentially affects not

only user commitment, but also (and in a completely different way) the quality or fit of the resulting system.

Implications for designing diagnostics for IS problems

As the TPC model becomes more solidly supported, and the critical role of TTF in delivering performance impacts is clarified, it suggests that TTF is an excellent focus for developing a diagnostic tool for IS systems and services in a particular company. To be most useful, such a diagnostic must go beyond general constructs (such as user satisfaction, usefulness, or relative advantage) to more detailed constructs (such as data quality, locatability, systems reliability, etc.) that can more specifically identify gaps between systems capabilities and user needs. Based on an understanding of specific gaps, managers may decide to: (1) discontinue or redesign systems or policies, (2) embark on training or selection programs to increase the ability of users, or (3) redesign tasks to take better advantage of IT potential (Goodhue, 1988). Beyond supporting the importance of the TTF construct, this research has pushed forward the effort to identify and measure distinct components of task-technology fit. Thus, it is an important step toward providing a meaningful diagnostic tool for practice.

Implications for future research

Construct measurement continues to be a key concern in this research domain. Although we have added to the base of knowledge concerning the measurement of TTF components (complementing the work of Goodhue (1993)) there is still ample room for improvement. The TTF measure now focuses on IT support for the user tasks of decision making, changing business processes, and executing routine transactions. Refining the existing TTF dimensions, or expanding to focus on more user tasks are both potential areas for improvement. In addition, our measures of the characteristics of information systems and services were admittedly crude. It would seem appropriate to explore the development of some standard set of measurable

dimensions for use in comparing the information technology base across companies. Similarly, it would be important to continue work on the issue of defining and measuring utilization to obtain a better understanding of the role of this construct. It is also important to go beyond *perceived* performance impacts, perhaps by constructing a laboratory environment in which the model can be tested with objective measures of performance.

A second avenue for future research is to expand the scope of testing across more diverse settings. Testing across a wider scope of companies would give a better sense of the relative importance of various components of TTF. Clearly there is a dilemma here since using more diverse settings would tend to dilute the impact of particular effects, but give greater clarity to effects that are more generally present. An additional opportunity is to explicitly examine feedback in the model. For example, an interesting area for investigation would be the effect of performance impacts on utilization, either directly or indirectly through changes in user ratings of TTF and perceived consequences of use.

Models are ways to structure what we know about reality, to clarify understandings, and to communicate those understandings to others. Once articulated and shared, a model can guide thinking in productive ways, but it can also constrain our thinking into channels consistent with the model, blocking us from seeing part of what is happening in the domain we have modeled. We believe the TPC model is a useful evolution of the models in which IT leads to performance impacts. It should provide a better basis for understanding these critical constructs and for understanding how they link to other related IS research issues.

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Appendix

Construct Measures and Descriptive Statistics

In each company, the basic research questionnaire was customized by inserting precise acronyms and terms so that names of systems and departments would be readily identifiable by the respondents.

PART A. TASK-TECHNOLOGY FIT MEASURES

8 Final Factors of TTF

21 Original Dimensions of TTF

Questions

Quality

CURRENCY: (Data that I use or would like to use is current enough to meet my needs.)

CURR1 — I can't get data that is current enough to meet my business needs.

CURR2 — The data is up to date enough for my purposes.

RIGHT DATA: (Maintaining the necessary fields or elements of data.)

RDAT1 — The data maintained by the corporation or division is pretty much what I need to carry out my tasks.

RDAT2 — The computer systems available to me are missing critical data that would be very useful to me in my job.

RIGHT LEVEL OF DETAIL: (Maintaining the data at the right level or levels of detail.)

RLEV1 — The company maintains data at an appropriate level of detail for my group's tasks.

RLEV2 — Sufficiently detailed data is maintained by the corporation.

Locatability

LOCATABILITY: (Ease of determining what data is available and where.)

LOCT1 — It is easy to find out what data the corporation maintains on a given subject.

LOCT3 — It is easy to locate corporate or divisional data on a particular issue, even if I haven't used that data before.

MEANING: (Ease of determining what a data element on a report or file means, or what is excluded or included in calculating it.)

MEAN1 — The exact definition of data fields relating to my tasks is easy to find out.

MEAN2 — On the reports or systems I deal with, the exact meaning of the data elements is either obvious, or easy to find out.

Authorization

AUTHORIZATION: (Obtaining authorization to access data necessary to do my job.)

AUTH1 — Data that would be useful to me is unavailable because I don't have the right authorization.

AUTH2 — Getting authorization to access data that would be useful in my job is time consuming and difficult.

Compatibility

COMPATIBILITY: (Data from different sources can be consolidated or compared without inconsistencies.)

COMP1 — There are times when I find that supposedly equivalent data from two different sources is inconsistent.

COMP2 — Sometimes it is difficult for me to compare or consolidate data from two different sources because the data is defined differently.

COMP3 — When it's necessary to compare or consolidate data from different sources, I find that there may be unexpected or difficult inconsistencies.

Production Timeliness

TIMELINESS: (IS meets pre-defined production turnaround schedules.)

PROD1 — IS, to my knowledge, meets its production schedules such as report delivery and running scheduled jobs.

PROD2 — Regular IS activities (such as printed report delivery or running scheduled jobs) are completed on time.

Systems Reliability

SYSTEMS RELIABILITY: (Dependability and consistency of access and uptime of systems.)

RELY1 — I can count on the system to be "up" and available when I need it.

RELY2 — The computer systems I use are subject to unexpected or inconvenient down times which makes it harder to do my work.

RELY3 — The computer systems I use are subject to frequent problems and crashes.

Ease of Use / Training

EASE OF USE OF HARDWARE & SOFTWARE: (Ease of doing what I want to do using the system hardware and software for submitting, accessing, analyzing data.

EASE1 — It is easy to learn how to use the computer systems I need.

EASE2 — The computer systems I use are convenient and easy to use.

TRAINING: (Can I get the kind of quality computer-related training when I need it?)

TRNG1 — There is not enough training for me or my staff on how to find, understand, access or use the company computer systems.

TRNG2 — I am getting the training I need to be able to use company computer systems, languages, procedures and data effectively.

Relationship with Users

IS UNDERSTANDING OF BUSINESS: (How well does IS understand my unit's business mission and its relation to corporate objectives?)

UNBS1 — The IS people we deal with understand the day-to-day objectives of my work group and its mission within our company.

UNBS2 — My work group feels that IS personnel can communicate with us in familiar business terms that are consistent.

IS INTEREST AND DEDICATION: (to supporting customer business needs.)

INDN1 — IS takes my business group's business problems seriously.

INDN2 — IS takes a real interest in helping me solve my business problems.

RESPONSIVENESS: (Turnaround time for a request submitted for IS service.)

RESP1 — It often takes too long for IS to communicate with me on my requests.

RESP2 — I generally know what happens to my request for IS services or assistance or whether it is being acted upon.

RESP3 — When I make a request for service or assistance, IS normally responds to my request in a timely manner.

CONSULTING: (Availability and quality of technical and business planning assistance for systems)

CONS1 — Based on my previous experience I would use IS technical and business planning consulting services in the future if I had a need.

CONS2 — I am satisfied with the level of technical and business planning consulting expertise I receive from IS.

IS PERFORMANCE: (How well does IS keep its agreements?)

PERF2 — IS delivers agreed-upon solutions to support my business needs.

PART B. TASK/JOB CHARACTERISTICS MEASURES

TASK EQUIVOCALITY

ADHC1 — I frequently deal with ill-defined business problems.

ADHC2 — I frequently deal with ad-hoc, non-routine business problems.

ADHC3 — Frequently the business problems I work on involve answering questions that have never been asked in quite that form before.

TASK INTERDEPENDENCE

INTR1 — The business problems I deal with frequently involve more than one business function.

INTR2 — The problems I deal with frequently involve more than one business function.

PART C. INDIVIDUAL PERFORMANCE IMPACT MEASURES

PERFORMANCE IMPACT OF COMPUTER SYSTEMS:

IMPT1 The company computer environment has a large, positive impact on my effectiveness and productivity in my job.

IMPT3 IS computer systems and services are an important and valuable aid to me in the performance of my job.

PART D. DIMENSIONS AND QUESTIONS DROPPED AS NOT SUCCESSFULLY MEASURED

CONFUSION. (Difficulty in understanding which systems or files to use in a given situation.) 2 questions.

ACCESSIBILITY. (Access to desired data.) 3 questions.

ACCURACY. (Correctness of the data.) 2 questions.

IS POLICIES, STANDARDS & PROCEDURES. (Impact of policies, standards & procedures on job.) 2 questions.

ASSISTANCE. (Ease of getting help with problems related to computer systems and data.) 3 questions.

Individual Questions Dropped: Locatability (1), IS performance meets goals (1), Performance impact (1).

PART E. DESCRIPTIVE STATISTICS

<u>Variable</u>	<u>N</u>	<u>Mean</u>	<u>Std Dev</u>	<u>Minimum</u>	<u>Maximum</u>
Relationship with Users	598	4.446977	0.956491	1.000000	7.000000
Quality	605	4.629835	1.075390	1.000000	7.000000
Production Timeliness	561	4.851159	1.086707	1.000000	7.000000
Compatibility	591	3.681331	1.117980	1.000000	7.000000
Locatability	600	3.702361	1.069070	1.000000	7.000000
Ease of Use/Training	609	4.118227	1.184834	1.000000	7.000000
Systems Reliability	604	4.311534	1.296419	1.000000	7.000000
Authorization	588	4.156463	1.316974	1.000000	7.000000
Non-Routine Tasks	581	4.202238	1.313822	1.000000	7.000000
Task Interdependence	578	4.664360	1.341179	1.000000	7.000000
Performance Impact	608	5.355263	1.203895	1.000000	7.000000
Total Dependence	559	4.044723	2.176727	0	10